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Final Report

**The Use of Ocean Color Measurements in
Coupled Physical-Biological Models with
Application to the Southeastern U. S. Continental Shelf**

Submitted by
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1. Project Summary

During the first year of this project, we obtained from NASA/Goddard Space Flight Center all of the winter (November to May) Level-1 Coastal Zone Color Scanner (CZCS) images for the southeastern U. S. continental shelf for the period 1978 to 1986. The resulting data set consisted of 357 images. These images were processed at the Center for Coastal Physical Oceanography at Old Dominion University using the PC-SEAPAK satellite image analysis system that was developed by personnel at NASA/Goddard Space Flight Center. The analysis of the resultant CZCS images has been in two parts. The first consisted of an in-depth analysis of the atmospheric correction parameters that are used in processing the CZCS images. The second is an analysis of the spatial coherence scales in the near-surface phytoplankton distributions that are derived from the CZCS.

An important parameter in the atmospheric correction algorithm used to process CZCS data is the one that expresses the spectral characteristic of the aerosol scattering in the atmosphere. This parameter is usually designated as ϵ . Typically a single value is used for this parameter and this single value is applied to all CZCS images. However, the CZCS data set from the southeastern U. S. continental shelf was used to calculate monthly values of ϵ . These show higher values of ϵ during the winter months (December and January), which likely reflect the higher concentrations of terrigenous types of tropospheric aerosols or continental haze. The input of this material during the winter may be related to the northwesterly winds that predominate over the southeastern U. S. continental shelf at this time. In addition to the seasonal variation, the values of ϵ decrease over the eight-year period covered by the CZCS images. This decrease is consistent with the results of other studies that show a decay in the CZCS sensor signal between 1981 and 1986.

Calculation of pigment concentrations from the CZCS using atmospheric correction parameters (ϵ values) for typical land aerosols and mean oceanic values yielded values that overestimated and underestimated the true pigment concentrations, respectively. The seasonal ϵ values gave results that agreed with actual values. This analysis shows a strong temporal variation in atmospheric correction parameters that are used to calculate pigment concentrations from satellite-derived ocean color measurements. These results suggest that future atmospheric correction and bio-optical algorithms should incorporate time-varying parameters. This is necessary before attempting large-scale estimates of primary production from satellite ocean color measurements.

The second portion of this research involved the application of statistical techniques to the CZCS images from the southeastern U. S. continental shelf. This analysis was designed to reveal the dominant across- and along-shelf coherence scales in the near-surface phytoplankton distributions. For each image, the four subregions were defined southeastern U. S. continental shelf on the basis of circulation and bathymetric features. Across- and along-shelf transects were selected within each sub-region and CZCS-derived chlorophyll concentrations were obtained along these lines. Variograms and autocorrelations were then calculated to determine dominant across- and along-shelf length scales associated with non-random structures.

This analysis showed that upwelling associated with Gulf Stream frontal eddies leads to coherent mesoscale patches of relatively high chlorophyll concentrations that are elongated along the shelf break. Upwelling associated with the cold air outbreaks that are associated with winter storms produces patches that are widely distributed along the mid and outer shelf regions. In the absence of episodic physical forcing, pigment concentrations on the mid to outer southeastern U. S. continental

shelf are low. The implication of these results is that satellite-derived ocean color measurements can be used to identify patterns that are characteristic of particular physical forcing events.

2. Students Supported

This project supported one Ph.D. student, Ms. Ana Martins. Ms. Martins finished the required course work and successfully completed her Ph.D. candidacy examinations during summer 1993. She is writing her Ph.D. dissertation and is expected to defend her dissertation research during Fall Semester 1994. After receiving her Ph.D. degree, Ms. Martins will return to Portugal, where she has a position at the University of the Azores.

3. Publication Citations

A. Published Abstracts

Martins, A., C. R. McClain and E. E. Hofmann, 1990, Variability in Phytoplankton Pigment Distribution on the Outer Southeastern U. S. Continental Shelf in Response to Winter Cold Air Outbreaks, *EOS*, 71(43), 1373.

Martins, A. M., 1991, Winter Variability of Near-surface Pigment Distributions in the South Atlantic Bight from 1978 to 1981, *EOS*, 72(51), 90.

Hofmann, E. E., A. M. Martins and C. R. McClain, 1992, Chlorophyll Patterns and Gulf Stream Frontal Variability on the Southeastern U. S. Continental Shelf from CZCS Measurements, *EOS*, 73(43), 266.

Martins, A. M., E. E. Hofmann and C. R. McClain, 1992, Winter Variability of Near-surface Pigment Concentrations on the Southeastern U. S. Continental Shelf, *EOS*, 73(43), 293.

B. Reviewed Publications

Martins, A., E. E. Hofmann and C. R. McClain, 1994, Seasonal Variability of CZCS-derived Atmospheric Correction Parameters on the Southeastern U. S. Continental Shelf from 1978 to 1986, manuscript in preparation for submission to *Journal of Geophysical Research*.

Martins, A. M., E. E. Hofmann and C. R. McClain, 1994, Winter Variability of Near-surface Pigment Concentrations on the Southeastern U. S. Continental Shelf, manuscript in preparation for submission to *Journal of Geophysical Research*.

C. Presentations

Martins, A., C. R. McClain and E. E. Hofmann, 1990, Variability in Phytoplankton Pigment Distribution on the Outer Southeastern U. S. Continental Shelf in Response to Winter Cold Air Outbreaks. Poster presented at 1990 Fall Meeting of the American Geophysical Union, San Francisco, CA, 3-7 December.

Martins, A. M., 1991, Winter Variability of Near-surface Pigment Distributions in the South Atlantic Bight from 1978 to 1981. Oral Presentation at 1992 Ocean Sciences Meeting, New Orleans, LA, 27-31 January.

Hofmann, E. E., A. M. Martins and C. R. McClain, 1992, Chlorophyll Patterns and Gulf Stream Frontal Variability on the Southeastern U. S. Continental Shelf from CZCS Measurements. Poster presentation at 1992 Fall Meeting of the American Geophysical Union, San Francisco, CA, 7-11 December.

Martins, A. M., E. E. Hofmann and C. R. McClain, 1992, Winter Variability of Near-surface Pigment Concentrations on the Southeastern U. S. Continental Shelf. Oral presentation at 1992 Fall Meeting of the American Geophysical Union, San Francisco, CA, 7-11 December.

4. Scientific Collaborators

This research project required considerable interaction with Dr. Charles R. McClain at NASA/Goddard Space Flight Center. Dr. McClain provided the ocean color data used in this analysis, spent time training Ms. Martins in use of the SEAPAK system, and helped in the interpretation of results. Our interaction with Dr. McClain was formalized by appointing him as an adjunct member of Ms. Martins' Ph.D. committee.